

Chapter 5 Review

1) The value of ΔE for a system that performs 111 kJ of work on its surroundings and gains 89 kJ of heat is _____ kJ.

- A) -111 B) -200 C) 200 **D) -22** E) 22

$$\begin{aligned}\Delta E &= W + q \\ &= (-111 \text{ kJ}) + (+89 \text{ kJ}) \\ &= -22 \text{ kJ}\end{aligned}$$

2) Which one of the following statements is true?

A) Enthalpy is an intensive property.

B) The enthalpy change for a reaction is independent of the state of the reactants and products.

C) Enthalpy is a state function.

D) H is the value of q measured under conditions of constant volume.

E) The enthalpy change of a reaction is the reciprocal of the ΔH of the reverse reaction.

3) The reaction $4 \text{ Al (s)} + 3 \text{ O}_2 \text{ (g)} \rightarrow 2 \text{ Al}_2\text{O}_3 \text{ (s)}$ $\Delta H^\circ = -3351 \text{ kJ}$ is _____, and therefore heat is _____ by the reaction.

- A) endothermic, released B) endothermic, absorbed **C) exothermic, released**
D) exothermic, absorbed E) thermoneutral, neither released nor absorbed

4) Under what condition(s) is the enthalpy change of a process equal to the amount of heat transferred into or out of the system?

- (a) temperature is constant (b) pressure is constant (c) volume is constant

- A) a only **B) b only** C) c only D) a and b E) b and c

5) A sample of iron absorbs 67.5 J of heat, upon which the temperature of the sample increases from 21.5 °C to 28.5 °C. If the specific heat of iron is 0.450 J/g·K, what is the mass (in grams) of the sample?

- A) 4.3 B) 11 **C) 21** D) 1100 E) 1.1×10^3

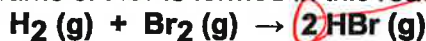
$$\begin{aligned}q &= m C_s \Delta T \\ m &= \frac{q}{C_s \Delta T} = \frac{67.5}{(0.450)(7)} = 21\end{aligned}$$

6) For which one of the following reactions is $\Delta H^\circ_{\text{rxn}}$ equal to the heat of formation of the product?

- A) $\text{N}_2 \text{ (g)} + 3 \text{ H}_2 \text{ (g)} \rightarrow 2 \text{ NH}_3 \text{ (g)}$ **B) $\frac{1}{2} \text{ N}_2 \text{ (g)} + \text{O}_2 \text{ (g)} \rightarrow \text{NO}_2 \text{ (g)}$**
C) $6 \text{ C (s)} + 6 \text{ H (g)} \rightarrow \text{C}_6\text{H}_6 \text{ (l)}$ D) $\text{P (g)} + 4 \text{ H (g)} + \text{Br (g)} \rightarrow \text{PH}_4\text{Br (l)}$
E) $12 \text{ C (g)} + 11 \text{ H}_2 \text{ (g)} + 11 \text{ O (g)} \rightarrow \text{C}_6\text{H}_{22}\text{O}_{11} \text{ (g)}$

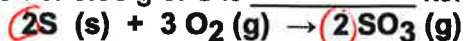
$\Delta H^\circ_{\text{rxn}} = \Delta H^\circ_{\text{f products}} - \Delta H^\circ_{\text{f reactants}}$
true, if reactants are zero (aka elements)

7) The value of ΔH° for the reaction below is -72 kJ. _____ kJ of heat are released when 80.9 grams of HBr is formed in this reaction.



- A) 144 B) 72 C) 0.44 **D) 36** E) -72

8) The value of ΔH° for the reaction below is -790 kJ. The enthalpy change accompanying the reaction of 0.95 g of S is _____ kJ.



- A) 23 B) -23 **C) -12** D) 12 E) -790

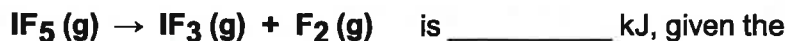
9) The specific heat capacity of lead is 0.13 J/g-K. How much heat (in J) is required to raise the temperature of 15 g of lead from 22 °C to 37 °C?

- A) 2.0 B) -0.13 C) 5.8×10^{-4} **D) 29** E) 0.13

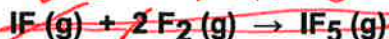
10) The specific heat of bromine liquid is 0.226 J/g · K. The molar heat capacity (in J/mol-K) of bromine liquid is _____.

- A) 707 **B) 36.1** C) 18.1 D) 9.05 E) 0.226

11) ΔH for the reaction:



$\Delta H = -390 \text{ kJ}$



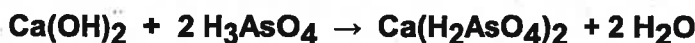
$\Delta H = -745 \text{ kJ}$

- A) +355** B) -1135 C) +1135 D) +35 E) -35

12) The specific heat of liquid bromine is 0.226 J/g-K. How much heat (J) is required to raise the temperature of 10.0 mL of bromine from 25.00 °C to 27.30 °C? The density of liquid bromine: 3.12 g/mL.

- A) 5.20 **B) 16.2** C) 300 D) 32.4 E) 10.4

13) Given the data in the table below, $\Delta H^\circ_{\text{rxn}}$ for the reaction



is _____ kJ.

Substance	ΔH_f° (kJ/mol)
$\text{Ca}(\text{OH})_2$	-986.6
H_3AsO_4	-900.4
$\text{Ca}(\text{H}_2\text{AsO}_4)_2$	-2346.0
H_2O	-285.9

$$\Delta H^\circ_{\text{rxn}} = [(-2346.0) + (-285.9)] - [(2 \times -900.4) + (-986.6)]$$

$$\Delta H^\circ_{\text{rxn}} = -130.4 \text{ kJ} \quad \leftarrow \text{correct!}$$

- A) -744.9 B) -4519 C) -4219 **D) -130.4** E) -76.4

14) The combustion of titanium produces titanium dioxide: $\text{Ti (s)} + \text{O}_2 \text{ (g)} \rightarrow \text{TiO}_2 \text{ (s)}$

When 2.060 g of titanium is combusted in a bomb calorimeter, the temperature of the calorimeter increases from 25.00 °C to 91.60 °C. In a separate experiment, the heat capacity of the calorimeter is measured to be 9.84 kJ/K. The heat of reaction for the combustion of a mole of Ti in this calorimeter is _____ kJ/mol.

- A) 14.3 B) 19.6 C) -311 D) -0.154 **E) -1.52×10^4**

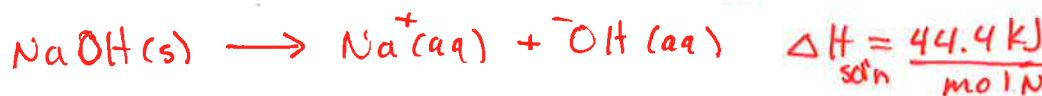
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attached
sheet for
work

15) A 5.00-g sample of liquid water at 25.0 °C is heated by the addition of 84.0 J of energy. The final temperature of the water is _____ °C. The specific heat capacity of liquid water is 4.18 J/g·K.

- A) 95.2 B) 25.2 C) -21.0 **D) 29.0** E) 4.02

16) The ΔH for the solution process when solid sodium hydroxide dissolves in water is 44.4 kJ/mol. When a 10.1-g sample of NaOH dissolves in 250.0 g of water in a coffee-cup calorimeter, the temperature increases from 23.0 °C to _____ °C. Assume that the solution has the same specific heat as liquid water, i.e., 4.18 J/g·K.

- A) 35.2 B) 24.0 C) 33.7 **D) 33.3** E) 40.2



can determine
for how much
we have

$m = 10.1 \text{ g}$
molar mass = 39.997 g/mol

water
250.0g

sol'n
 $T_i = 23.0^\circ\text{C}$
 $C_s = \frac{4.18 \text{ J}}{\text{g} \cdot \text{K}}$

Want
 $T_f = ?$

$$10.1 \text{ g NaOH} \times \frac{\text{mol NaOH}}{39.997 \text{ g NaOH}} = 0.253 \text{ mol}$$

$$m_{\text{sol'n}} = \text{mass}_{\text{water}} + \text{mass}_{\text{NaOH}}$$

$$= 250.0 \text{ g} + 10.1 \text{ g}$$

$$m_{\text{sol'n}} = 260.1 \text{ g}$$

$$q_{\text{sol'n}} = m C_s \Delta T \quad \leftarrow \text{solve for}$$

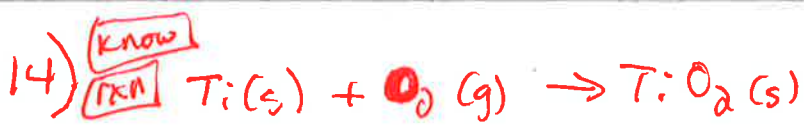
$$\Delta T = \frac{q_{\text{sol'n}}}{m_{\text{sol'n}} C_s} = \frac{\left(\frac{44.4 \text{ kJ}}{\text{mol NaOH}} \right) (0.253 \text{ mol NaOH}) \left(\frac{1}{260.1 \text{ g}} \right) \left(\frac{\text{g} \cdot \text{K}}{4.18 \text{ J}} \right) \left(\frac{1000 \text{ J}}{1 \text{ kJ}} \right)}{1} = 10.3 \text{ K}$$

$$\Delta T = 10.3^\circ\text{C} = T_f - T_i$$

$$10.3^\circ\text{C} + T_i = T_f$$

$$10.3^\circ\text{C} + 23.0^\circ\text{C} = T_f$$

$$T_f = 33.3^\circ\text{C}$$



$$m = 2.060 \text{ g}$$

$$\text{molar mass} = 47.88 \text{ g/mol}$$

calorimeter

$$\Delta T = 91.60 - 25.00^\circ\text{C} = 66.60^\circ\text{C} = 66.60 \text{ K}$$

$$C_p(\text{calorimeter}) = \frac{9.84 \text{ kJ}}{\text{K}}$$

$$q = C_p(\text{calorimeter}) \Delta T$$

$$\Delta H_{\text{rxn}} = -C_p(\text{calorimeter}) \Delta T$$

$$= -\frac{9.84 \text{ kJ}}{\text{K}} \times 66.60 \text{ K} = -655 \text{ kJ}$$

$$2.060 \text{ g Ti} \times \frac{\text{mol Ti}}{47.88 \text{ g Ti}} = 0.04302 \text{ mol Ti}$$

calorimeter
rxn

$$q_{\text{calorimeter}} = -q_{\text{rxn}}$$

want

$$\frac{q_{\text{rxn}}(\text{kJ})}{1 \text{ mol Ti}} = \frac{-655 \text{ kJ}}{0.04302 \text{ mol Ti}}$$

$$= -15223.98 \text{ kJ/mol}$$

$$= \boxed{-1.52 \times 10^4 \text{ kJ/mol}}$$

15) know H_2O

$$m = 5.00 \text{ g}$$

$$q = 84.0 \text{ J}$$

$$T_i = 25.0^\circ\text{C}$$

$$C_s = \frac{4.18 \text{ J}}{\text{g} \cdot \text{K}}$$

want

$$T_f = ? (^\circ\text{C})$$

$$q = m C_s \Delta T$$

$$\Delta T = \frac{q}{m C_s}$$

$$T_f - T_i = \frac{q}{m C_s} + T_i$$

$$T_f = \frac{q}{m C_s} + T_i = \left(\frac{84.0 \text{ J}}{5.00 \text{ g} \times 4.18 \text{ J/g} \cdot \text{K}} \right) + (25.0 + 273)$$

need to be same units to add

$$T_f = 302.0 \text{ K} - 273 = \boxed{29.0^\circ\text{C}}$$

Chapter 5 Review – KEY

- 1) D
- 2) C
- 3) C
- 4) B
- 5) C
- 6) B
- 7) D
- 8) C
- 9) D
- 10) B
- 11) A
- 12) B
- 13) D
- 14) E
- 15) D
- 16) D